

# APPLICATION UNDER UNITED STATES PATENT LAWS

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Invention: OPTICAL DISK APPARATUS AND OPTICAL DISK PROCESSING METHOD

Inventor (s): Akira KAWAMURA

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## SPECIFICATION

TITLE OF THE INVENTION

OPTICAL DISK APPARATUS AND OPTICAL DISK PROCESSING  
METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

5 This application is based upon and claims the benefit of priority from prior Japanese Patent Application No. 2003-161039, filed June 5, 2003, the entire contents of which are incorporated herein by reference.

10 BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an optical disk apparatus, particularly to an optical disk recording and reproducing apparatus and an optical disk processing method, which perform double-speed readout on the basis of management information (for example, navigation pack).

2. Description of the Related Art

In recent years, the optical disk apparatus is improved and the optical disk apparatus becomes widespread. Even in technologies of this field, the higher-level technology is demanded. One of the demanded technologies of the field is to perform smoothly reproduction, even in processing of reading out and reproducing contents of an optical disk not at one double speed but at high double speed. Utilization of a buffer memory is required for the reproduction of

the contents at high speed.

In the prior art (Jpn. Pat. Appln. KOKAI Publication No. 2000-101970) concerned with the reproduction of the contents at high speed, there is disclosed a reproducing apparatus and reproducing method in which the backward reproduction is performed by utilizing the buffer memory. In Jpn. Pat. Appln. KOKAI Publication No. 2000-101970, data which has been read out from the optical disk and reproduced is stored in the buffer memory, and the data is properly read out from the buffer memory when the backward reproduction is required.

In the prior art, it is shown that the buffer memory is utilized in the case of the special reproduction. However, no specific solution is given to the following problem of the invention shown below.

That is, in the optical disk apparatus according to the invention, although contents information is read in each chapter in the buffer memory, all pieces of the contents information are not read in the buffer memory. For example, in the case of four double speed or eight double speed, the contents information is captured in the buffer memory in each reproducing unit (for example, VOBU (Video Object Unit)) of an address indicating management information such as navigation pack (NV\_PCK). Even in the contents information which has read at one double speed, the contents information

which is not read at four double speed is present.

The processing of reproducing the contents information is divided into capture processing which captures the contents information in the buffer by 5 using a read buffer, a fore-control unit, and the like, and then the processing which reads out the contents information from the read buffer to encode the contents information by using the stream control unit and the like included in the encoder and the like. In the 10 stream control unit, for example, when an end point of the contents information in one chapter is detected, an end position of one chapter is informed to the fore-control unit again. According to the information of the end position of one chapter, the fore-control unit 15 resumes the readout of the contents information of the next chapter.

Thus, since the step of capturing the contents information in the fore-control unit and the step of encoding the contents information in the stream control unit of the post-control unit are performed at different timing, the following problem is generated by the user operation in the case where the reproducing speed is changed from the eight double speed to the one double speed in readout processing.

That is, even in the case where the reproducing speed is changed from the eight double speed to the one double speed in detecting the end position of the 25

contents information in the stream control unit of the post-control unit, the contents information given from the read buffer becomes previous one which is read at the eight double speed. Therefore, while the stream control unit currently recognizes the reproducing speed as the one double speed, the stream control unit detects the end point of the contents information for the contents information which is read at eight double speed and fails the detection of the end point.

In order to avoid the above problem, it is necessary to restrict the processing such that the read operation of the next chapter is not performed until all the read buffers become empty when the reproducing speed is changed. However, since the restriction of the processing leads to decreases in the read speed and the reproducing speed, when the reproducing speed is changed during the reproduction, there is the problem that sufficient processing speed can not be obtained.

#### BRIEF SUMMARY OF THE INVENTION

According to an aspect of the invention, there is provided an optical disk apparatus comprising a detection unit which detects one information unit in one of a plurality of areas from an optical disk which stores the plurality of information units including management information and contents information corresponding to the management information in the plurality of areas, a reading unit which stores the

information unit including the management information and the contents information in a buffer and performs control in order to read the information unit from the buffer at predetermined timing, and a reproducing unit  
5 which decodes and reproduces the contents information read out from the buffer by control of the reading unit.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

FIG. 1 is a block diagram showing a configuration  
10 of an optical disk apparatus which is of an embodiment  
of the invention;

FIG. 2 is an explanatory view for explaining read operation of the optical disk apparatus which is of an embodiment of the invention;

15 FIG. 3 is a view showing one of examples of management information treated by the optical disk apparatus which is of an embodiment of the invention;

FIG. 4 is a flow chart showing one of processing operations of a fore-control unit which is of the  
20 optical disk apparatus according to a first embodiment  
of the invention;

FIG. 5 is a flow chart showing one of processing operations of a post-control unit which is of the  
optical disk apparatus according to the first  
25 embodiment of the invention;

FIG. 6 is a flow chart showing one of processing operations of the fore-control unit which is of the

optical disk apparatus according to a second embodiment  
of the invention;

FIG. 7 is a flow chart showing one of processing  
operations of the post-control unit which is of  
5 the optical disk apparatus according to the second  
embodiment of the invention;

FIG. 8 is a flow chart showing one of processing  
operations of the fore-control unit which is of the  
optical disk apparatus according to a third embodiment  
10 of the invention; and

FIG. 9 is a flow chart showing one of processing  
operations of the post-control unit which is of the  
optical disk apparatus according to the third  
embodiment of the invention.

15 DETAILED DESCRIPTION OF THE INVENTION

Referring to the accompanying drawings, the  
optical disk apparatus which is of an embodiment of the  
invention will be described in detail below. FIG. 1 is  
a block diagram showing a configuration of the optical  
20 disk apparatus which is of an embodiment of the  
invention, FIG. 2 is an explanatory view for explaining  
read operation, and FIG. 3 shows one of examples of  
management information treated by the optical disk  
apparatus which is of an embodiment of the invention.

25 [Optical Disk Apparatus according to the Invention]  
(Basic Configuration and Operation)

In FIG. 1, an optical disk apparatus A which is of

an embodiment of the invention includes a ROM and a RAM 60 which are a storage area and a control unit 61 which controls overall operation and the like. The optical disk apparatus A also includes a rotary motor M which rotates an optical disk D at predetermined number of revolutions and a servo control unit 52. Further, the optical disk apparatus A includes a pickup head PUH which writes information in the optical disk D and reads out the information from the optical disk D.

The pickup head PUH includes an objective lens L, a photodetector PD such as a four-channel photodetector and a laser diode LD which emits a laser beam, and head amplifier.

The servo control unit 52 is connected to processing circuits of servo control system 55. The processing circuits of servo control system 55 include an objective lens guiding circuit, a focus control circuit, an objective lens driving signal switch, an objective lens driving circuit, a wobble (WB) signal detector and the like, which are not shown. The processing circuits of servo control system 55 perform focus retracting operation and the like.

The optical disk apparatus A also includes a signal processing unit 56 to which a detection signal is supplied from the photodetector PD of the pickup head PUH and a read buffer 57 which perform modulating/demodulating processing or ECC processing to a signal

to be recorded which is given from the outside or the  
5 detection signal detected by the pickup head PUH. The  
data processing unit 58 is connected to a RAM 59 which  
provides a working area and an interface (I/F) 65 which  
exchanges the signal between the optical disk apparatus  
A and an external device.

In the above configuration, the control unit 61  
uses the RAM 60 as the working area and performs  
the predetermined operation according to a program  
10 including the invention which is recorded in the RAM  
60. The optical disk D is irradiated with a light beam  
output from the pickup head PUH. The reflected light  
beam from the optical disk D is converted into an  
electric signal by the head amplifier. The electric  
15 signal is stored in the read buffer 57 through the  
data processing unit 56, and then input to the data  
processing unit 58.

The objective lens guiding circuit, the focus  
control circuit, the objective lens driving signal  
20 switch, the objective lens driving circuit, the wobble  
(WB) signal detector, and the like, which are not shown  
and are includes in the processing circuits of servo  
control system 55, perform the focus retracting  
operation and the like.

25 In data writing operation, by using a write clock  
generated by a write channel circuit (not shown), the  
data processing unit 58 adds an error detection code

(EDC) and an ID to the data transmitted through the I/F 25, performs data scramble processing to the data in order to stabilize the servo, adds an error correction code (ECC) to the data, and adds a synchronizing signal 5 to the data. Further, the data processing unit 58 modulates the signals except the synchronizing signal and transmits the signals except the synchronizing signal to a write power control unit 63. The signals except the synchronizing signal are written in the 10 optical disk D through a laser diode driving circuit 64 by optimum write strategy for the corresponding medium.

In data readout operation, the detection signal from the pickup head PUH is amplified by the signal processing unit 56 and transmitted to the read buffer 15 57 through an optimum equalizer. Channel data is read in the read buffer 57 with a readout clock generated by a PLL circuit (not shown). In the data which has been read, synchronized symbol data is read out by the data processing unit 58. Then, error correction processing 20 and disk scramble processing are performed, and the data is transferred to the external device or the like through the I/F 65.

In the optical disk apparatus having the above basic structure and basic function, the processing of 25 obtaining and reproducing the stored information in the case of a change in the reproducing speed during the reproducing processing, which is of the embodiment of

the invention is considered, will be described in detail by using the flow chart.

[Optical Disk Apparatus according to First Embodiment]

A first embodiment is the optical disk apparatus  
5 and the optical disk processing method in which the fore-control unit writes the next search address in management information such as NV\_PCK and the post-control unit detects absence of the search address in the management information and decides an end of a  
10 chapter to transfer to capture of the next chapter.

(Reason for Processing Delay)

The optical disk apparatus according to the embodiment of the invention is one which shows a procedure of performing smoothly capture processing of  
15 contents information. In the optical disk apparatus, the contents information is read in the buffer memory in each chapter. However, in the case of high double-speed, all pieces of the contents information are not read.

FIG. 2 shows a state in which the optical disk apparatus A reads some of VOBUs in a plurality of VOBUs from VOBU\_A to VOBU\_P into the read buffer 57 while other VOBUs are properly skipped by high-speed readout.  
20 The capture processing into the read buffer 57 is performed by the control unit 61 which is of the fore-control unit shown in FIG. 1, and the processing of deciding the final VOBU in the chapter is performed by  
25

the stream control unit 62 which is of the post-control unit.

FIG. 3 shows address information in each VOBU. As shown in FIG. 2, the address information is included  
5 in a navigation pack (NV\_PCK) NP which is of the management information arranged in a front end of each VOBU. For example, in the address information of VOBU\_A, FIG. 3 shows that the address of VOBU\_A is 1000, the address of the next VOBU is 2000 in the case  
10 where the reproduction is performed in one double speed, the address of the second next VOBU is 3000 in the case where the reproduction is performed in four double speed, and the address of the next VOBU is 5000 in the case where the reproduction is performed in  
15 eight double speed.

As shown in FIG. 2 and FIG. 3, when the double speed is initially selected, as shown in the address information of VOBU\_A shown in FIG. 3, it is known that the next VOBU is VOBU\_B having the address of 2000 which is the search address of X1. When the four double speed is selected next in VOBU\_B, VOBU\_D having the address of 4000 which is of the search address of X4 is selected. Then, VOBU\_F is selected in the same way. When the eight double speed is selected next in  
20 VOBU\_J, VOBU\_N having the address of 10000 which is of the search address of X8 is selected. Then, VOBU\_N is selected in the same way. Under control of the control  
25

unit 61 which is of the fore-control unit, these VOBUs are read by the action of the pickup head PUH and stored in the read buffer 57.

The processing of reproducing the contents information is mainly divided into tow steps, i.e. the capture processing which captures the contents information in the buffer by using the read buffer, the fore-control unit, and the like, and then the processing which reads out the contents information from the read buffer to encode the contents information by using the stream control unit and the like included in the encoder and the like. In the stream control unit 62, for example, when an end point of the contents information in one chapter is detected, an end position of one chapter is informed to the fore-control unit 61. According to the information of the end position of one chapter, the fore-control unit 61 resumes the readout of the contents information of the next chapter.

Thus, since the step of capturing the contents information in the fore-control unit and the step of encoding the contents information in the stream control unit of the post-control unit are performed at different timing, the following problem is generated by the user operation in the case where the reproducing speed is changed from the eight double speed to the one double speed in readout processing.

That is, even in the case where the reproducing

speed is changed from the eight double speed to the one double speed in detecting the end position of the contents information in the stream control unit of the post-control unit, the contents information given from 5 the read buffer becomes previous one which is read at the eight double speed. Therefore, while the stream control unit 62 currently recognizes the reproducing speed as the one double speed, the stream control unit 62 detects the end points of the contents information 10 for the contents information which is read at eight double speed and fails the detection of the end point.

In order to avoid the above problem, it is necessary to restrict the processing such that the read operation of the next chapter is not performed until 15 all the read buffers become empty when the reproducing speed is changed (or even if the reproducing speed is not changed). However, since the restriction of the processing leads to decreases in the read speed and the reproducing speed, delay of the reproducing processing 20 occurs or the reproduction is not smoothly performed.

As described below, the first embodiment is one in which the fore-control unit writes the next search address in management information such as NV\_PCK and the post-control unit detects absence of the search 25 address in the management information and decides an end of a chapter to transfer to capture of the next chapter. Accordingly, since it is not necessary to

capture the contents information after the read buffers become empty in each chapter, the read processing and reproducing processing can be smoothly performed at high speed.

5 (Specific Processing Method)

FIG. 4 is the flow chart showing one of processing operations of the fore-control unit which is of the optical disk apparatus according to the first embodiment of the invention, and FIG. 5 is the flow chart 10 showing one of processing operations of the post-control unit.

In the flow chart shown in FIG. 4, when reproducing direction is received, the reflected light beam of the laser beam emitted from the pickup head PUH is 15 received with the photodetector PD under the control of the control unit 61 of the fore-control unit, the detection signal according to the reflected light beam received with the photodetector PD is processed by the signal processing unit and the like through the head amplifier, and then the initial VOBU is supplied to the read buffer. As described later in a third embodiment, it is preferable to obtain the address information 20 (address of the contents information of one chapter) which is of chapter management information in each chapter. When NV\_PCK of the initial VOBU is detected 25 (S11), NV\_PCK of the initial VOBU is captured in the RAM 60 of the working memory or the like (S12), and the

address of VOBU to be searched next according to the current reproducing speed (one double speed, four double speed, eight double speed, and the like) is read from the address information in NV\_PCK (S13).

5       At this point, when the eight double speed is selected, as shown in FIG. 3, the address of "5000" is additionally written in a reserve area of the address information as the search address (S14). Then, VOBU\_E indicated by "5000" of the search address is detected.  
10      The processing operation returns to step S11 as long as the search address is continued, and the processing is repeated until the contents information in the chapter is completely captured.

15      When the search address becomes lost, in step S14, absence of the search address is written in the reserve area, and it is preferable that data of "FF" is written in the reserve area. Accordingly, when the search address becomes lost, the processing is in a standby state for waiting a read start direction from the stream control unit 62 of the post-control unit.  
20

25      In the flow chart shown in FIG. 5, the stream control unit 62 of the post-control unit sequentially reads VOBU stored in the read buffer 57 and performs the control of the reproducing processing such as encode processing. At the same time, the stream control unit 62 decides whether VOBU is the end of the chapter or not. When the stream control unit 62

decides that VOBU is the end of the chapter, the stream control unit 62 gives the read start direction of the next chapter to the control unit 61 of the fore-control unit.

5        When NV\_PCK is detected (S21), the search address which is of an additional address is read out from the reserve area of the address information in NV\_PCK (S22). At this point, when the usual address is present, since it is not an end position, the processing operation returns to step S21 and the stream control unit 62 continues the processing of the next VOBU. When the state in which the address is absent is detected, e.g. when a value such as the above address of "FF" (any information to indicate the end position) is detected (S23), the stream control unit 62 decides that the chapter is ended and gives the start direction to the fore-control unit 61 so that the fore-control unit 61 starts to capture the next chapter (S24). The processing is continued until, e.g. a title end is detected (S25).

20       The search address is managed by utilizing the reserve area of the address information of NV\_PCK with the fore-control unit 61 and the post-control unit 62. As a result, even if a user changes the reproducing speed through the reproduction, the post-control unit 62 never fails recognition of the end position, so that it is not necessary to take measures such that the read

buffer 57 empty in each chapter. Therefore, the reproducing processing can be very smoothly performed.  
[Optical Disk Apparatus according to Second Embodiment]

A second embodiment is the optical disk apparatus  
5 and the optical disk processing method in which the fore-control unit writes reproducing magnification during capturing the contents information in the management information such as NV\_PCK and the post-control unit searches the search address from NV\_PCK in accordance with the reproducing magnification during 10 capturing the contents information, detects absence of the search address in the management information, and decides the end of the chapter to transfer to the capture of the next chapter.

15 FIG. 6 is the flow chart showing one of processing operations of the fore-control unit which is of the optical disk apparatus according to the second embodiment of the invention, and FIG. 7 is the flow chart showing one of processing operations of the post-control unit.  
20

In the flow chart shown in FIG. 6, when the reproducing direction is received, the reflected light beam of the laser beam emitted from the pickup head PUH is received with the photodetector PD under the control 25 of the control unit 61 of the fore-control unit, the detection signal according to the reflected light beam received with the photodetector PD is processed by the

signal processing unit 56 and the like through the head amplifier, and then the initial VOBU is supplied to the read buffer. When NV\_PCK of the initial VOBU is detected (S31), NV\_PCK of the initial VOBU is captured 5 in the RAM 60 of the working memory or the like (S32), and the address of VOBU to be searched next according to the current reproducing speed (one double speed, four double speed, eight double speed, and the like) is read from the address information in NV\_PCK (S33).

10 At this point, when the eight double speed is selected, as shown in FIG. 3, the eight double speed, e.g. "8" is additionally written in the reserve area of the address information (S34). Then, VOBU\_E indicated by "5000" of the search address is detected. The 15 processing operation returns to step S11 as long as the search address is continued, and the processing is repeated until the contents information in the chapter is completely captured. When the search address becomes lost, the processing is in the standby state 20 for waiting the read start direction from the stream control unit 62 of the post-control unit.

In the flow chart shown in FIG. 7, the stream control unit 62 of the post-control unit sequentially reads VOBU stored in the read buffer 57 and performs 25 the control of the reproducing processing such as encode processing. At the same time, the stream control unit 62 decides whether VOBU is the end of the

chapter or not. When the stream control unit 62 decides that VOBU is the end of the chapter, the stream control unit 62 gives the read start direction of the next chapter to the control unit 61 of the fore-control unit.

When NV\_PCK is detected (S41), the reproducing magnification during capturing the contents information is read out from the reserve area of the address information in NV\_PCK (S42). The address according to the reproducing magnification is obtained from the address information in NV\_PCK shown in FIG. 3 (S43). At this point, when the usual address is present, since it is not an end position, the processing operation returns to step S41 and the stream control unit 62 continues the processing of the next VOBU. When the state in which the address is absent is detected, e.g. when the value such as the above address of "FF" (any information to indicate the end position) is detected (S44), the stream control unit 62 decides that the chapter is ended and gives the start direction to the fore-control unit 61 so that the fore-control unit 61 starts to capture the next chapter (S45). The processing is continued until, e.g. the title end is detected (S46).

The reproducing magnification during capturing the contents information is managed by utilizing the reserve area of the address information of NV\_PCK with

the fore-control unit 61 and the post-control unit 62. As a result, even if the user changes the reproducing speed through the reproduction, the post-control unit 62 never fails recognition of the end position, so  
5 that it is not necessary to take measures such that the read buffer 57 empty in each chapter. Accordingly, similarly to the first embodiment, even in the second embodiment, the problem that the reproduced image is frozen can be eliminated and the reproducing processing  
10 can be very smoothly performed.

[Optical Disk Apparatus according to Third Embodiment]

A third embodiment is the optical disk apparatus and the optical disk processing method in which the fore-control unit additionally writes the final contents information (VOBU) of the chapter in a back end of the image of the chapter in accordance with the management information such as NV\_PCK and the post-control unit decides the end of the chapter to transfer to the capture of the next chapter when the post-control unit monitors the address of the one double speed of NV\_PCK and the like to detect the final image.  
20

FIG. 8 is the flow chart showing one of processing operations of the fore-control unit which is of the optical disk apparatus according to the third embodiment of the invention, and FIG. 9 is the flow chart showing one of processing operations of the post-control unit.  
25

In the flow chart shown in FIG. 8, when the  
reproducing direction is received, the reflected light  
beam of the laser beam emitted from the pickup head PUH  
is received with the photodetector PD under the control  
5 of the control unit 61 of the fore-control unit, the  
detection signal according to the reflected light beam  
received with the photodetector PD is processed by the  
signal processing unit 56 and the like through the head  
amplifier, and then the initial VOBU is supplied to the  
10 read buffer. At this point, the address information  
(address of the contents information of one chapter)  
which is of the chapter management information in each  
chapter is obtained. When NV\_PCK of the initial VOBU  
is detected (S51), NV\_PCK of the initial VOBU is  
15 captured in the RAM 60 of the working memory or the  
like (S52), and the address of VOBU to be searched next  
according to the current reproducing speed (one double  
speed, four double speed, eight double speed, and the  
like) is read from the address information in NV\_PCK  
20 (S53).

Then, VOBU\_E indicated by "5000" of the search  
address is detected. The processing operation returns  
to step S11 as long as the search address is continued,  
and the processing is repeated until the contents  
25 information in the chapter is completely captured  
(S54).

When the search address becomes "nothing", the

final contents information (VOBU) of the chapter, i.e. the contents information of VOBU\_P shown in FIG. 3 is obtained by the chapter management information in each chapter, which has been initially obtained, and the  
5 contents information of VOBU\_P is added to the back end of the contents information which has already been obtained (S55). Then, the processing is in the standby state for waiting the read start direction from the stream control unit 62 of the post-control unit.

10 In the flow chart shown in FIG. 9, the stream control unit 62 of the post-control unit sequentially reads VOBU stored in the read buffer 57 and performs the control of the reproducing processing such as encode processing. At the same time, the stream  
15 control unit 62 decides whether VOBU is the end of the chapter or not. When the stream control unit 62 decides that VOBU is the end of the chapter, the stream control unit 62 gives the read start direction of the next chapter to the control unit 61 of the fore-control  
20 unit.

When NV\_PCK is detected (S61), the address information corresponding to the one double speed of the address information in NV\_PCK is obtained (S62). When the address corresponding to the one double speed  
25 is the usual address, since it is not the end position, the processing operation returns to step S61 and the stream control unit 62 continues the processing of the

next VOBU. When the state in which the address is absent is detected, e.g. when the value such as the above address of "FF" (any information to indicate the end position) is detected (S63), the stream control unit 62 decides that the chapter is ended and gives the start direction to the fore-control unit 61 so that the fore-control unit 61 starts to capture the next chapter (S64). The processing is continued until, e.g. the title end is detected (S65).

The fore-control unit 61 adds the contents information of the final VOBU of the chapter to the back end of the read information and the post-control unit 62 continues to monitor "nothing" of search address of the address information of the one double speed in NV\_PCK. As a result, even if the user changes the reproducing speed through the reproduction, the post-control unit 62 never fails recognition of the end position, so that it is not necessary to take measures such that the read buffer 57 empty in each chapter.

Accordingly, similarly to the first and second embodiments, the problem that the reproduced image is frozen can be eliminated and the reproducing processing can be very smoothly performed.

Those skilled in the art could realize the invention by the various embodiments described above. Further, various modifications of the embodiments could be easily conceived by those skilled in the art, and

the invention could be applied to various embodiments without any inventive ability. Therefore, it is to be understood that the invention covers the broad scope which is consistent with the disclosed principle and  
5 the novel feature and the invention is not limited to the above-described embodiments.

As described in detail above, the invention uses the method in which the management of the search address is performed in the reserve area of the  
10 management information such as NV\_PCK by the fore-control unit and the post-control unit. As a result, even in the case where the reproducing speed is changed during the reproduction, the end position is always correctly decided, and it is not necessary to take  
15 measures such that the read buffer 57 becomes empty in each chapter, so that the optical disk apparatus and the optical disk processing method in which the reproducing processing is smoothly performed can be provided.